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Physical Activity Behavior of Patients 1 Year After Primary Total Hip Arthroplasty: A Prospective Multicenter Cohort Study

Robert Wagenmakers, Martin Stevens, Johan W. Groothoff, Wiebren Zijlstra, Sjoerd K. Bulstra, Jan van Beveren, Jos J.A.M. van Raaij, Inge van den Akker-Scheek

Background. Besides the important beneficial effects of regular physical activity on general health, some of the musculoskeletal effects of physical activity are of particular interest for older adults after total hip arthroplasty (THA). However, research on physical activity behavior of patients after THA is scarce.

Objective. The purpose of this study was to gain insight into the physical activity behavior and fulfillment of guidelines for health-enhancing physical activity of patients 1 year after THA.

Design. This was a prospective multicenter cohort study.

Methods. To determine level of physical activity, 653 participants (response rate=77%) completed the Short QuesTionnaire to ASsess Health-enhancing physical activity (SQUASH). Comparisons were made between participants in 2 age groups (≤ 75 and > 75 years). Determinants of physical activity behavior were assessed.

Results. The participants were physically active a mean of 1,468 minutes per week. Most time was spent in household and leisure activities. Younger participants were physically more active than older participants. A lower body mass index was predictive of a higher level of physical activity. Participants adhered to the guidelines of health-enhancing physical activity in 67% of cases. The guidelines were met more often by younger participants, male participants, and those without problems in the lower extremities.

Limitations. A nonresponse analysis was not conducted; thus, there might have been a selection bias. Use of a self-administered recall questionnaire to assess physical activity behavior may have been subject to memory and recall skill limitations of the participants, and patients tend to overestimate their physical activity level.

Conclusions. This study gives detailed insight into the physical activity of patients 1 year after primary THA. As among the general population, a considerable number of patients were found to be insufficiently physically active.

R. Wagenmakers, MD, PhD, is Orthopedic Surgeon, Department of Orthopedics, University Medical Center Groningen, University of Groningen, the Netherlands.

M. Stevens, PhD, is Research Coordinator, Department of Orthopedics, University Medical Center Groningen, University of Groningen, Hanzeplein 1, PO Box 30001, 9700 RB Groningen, the Netherlands. Address all correspondence to Dr Stevens at: m.stevens@orth.umcg.nl.

J.W. Groothoff, PhD, is Professor of Work and Health, Department of Health Sciences, University Medical Center Groningen, University of Groningen.

W. Zijlstra, PhD, is Human Movement Scientist, Center for Human Movement Sciences, University Medical Center Groningen, University of Groningen.

S.K. Bulstra, MD, PhD, is Professor of Orthopedics, Department of Orthopedics, University Medical Center Groningen, University of Groningen.

J. van Beveren, MD, is Orthopedic Surgeon, Department of Orthopedics, Röpke-Zweers Hospital, Hardenberg, the Netherlands.

J.J.A.M. van Raaij, MD, PhD, is Orthopedic Surgeon, Department of Orthopedics, Martini Hospital, Groningen, the Netherlands.

I. van den Akker-Scheek, PhD, is Research Coordinator, Department of Orthopedics, University Medical Center Groningen, University of Groningen, and Department of Orthopedics, Martini Hospital.

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In Western society, regular physical activity is considered to be one of the most important lifestyle behaviors affecting health.¹ It has been shown to be effective in the primary and secondary prevention of several chronic conditions and is linked to a reduction in all-cause mortality.^{1,2} It also enhances musculoskeletal fitness, which is positively associated with functional autonomy in older adults.^{3,4} At the same time, lack of physical activity is considered to be an important burden on public health,⁵ contributing together with an unhealthy diet to society's epidemic of obesity.^{6,7} For these reasons, international guidelines for levels of health-enhancing physical activity have been developed. These guidelines originally recommended 30 minutes or more of moderate to intense physical activity at least 5 days per week.^{8,9} The guidelines were updated in 2007, now recommending 30 minutes or more of moderate-intensity aerobic (endurance) physical activity at least 5 days per week, or vigorous-intensity physical activity for a minimum of 20 minutes at least 3 days per week.^{10,11}

Current population surveys provide detailed information on the physical activity behavior of the general population,^{6,12} showing that large segments are insufficiently physically active. In 2007, only 39.3% of American adults aged 65 years and older met the guidelines,¹² whereas in the Netherlands 66% of adults aged 55 years and older met the guidelines.⁶

However, little is known about the physical activity behavior of a large and growing^{13,14} subset of the population: patients after total hip arthroplasty (THA). Besides the important beneficial effects of regular physical activity on general health, some of the musculoskeletal effects of physical activity are of particular interest for older adults after THA. For example, improvement of muscle strength (force-generating capacity), balance, and coordination by means of regular physical activity has proven to be an effective strategy in the prevention of falls.^{15,16} In the presence of a prosthesis, falls may result in periprosthetic fracture, implant loosening, or dislocation of the hip prosthesis and cause serious morbidity. Furthermore, there are indications that increased bone density due to physical activity improves prosthetic fixation, reducing the risk of prosthetic loosening.¹⁷⁻¹⁹ Finally, physical activity might minimize bone loss caused by stress shielding,²⁰ as preservation of the quality and quantity of cortical bone is important should revision become necessary.

Research on physical activity after THA, however, is scarce. Studies conducted on this topic (eg, Bauman et al,²¹ Beaulé et al,²² and Chatterji et al²³) can be criticized for their use of the UCLA Activity Score²⁴ or Grimby scale,²⁵ whereby patients are categorized based on their level of physical activity. A major disadvantage of the use of such scales is that although they do give an impression of the level of physical activity, they do not provide detailed information on duration, frequency, and energy expenditure of the activities. Consequently, it cannot be determined to what extent patients fulfill the guidelines for health-enhancing physical activity. We, therefore, published a study in 2008 in which the Short Questionnaire to ASsess Health-enhancing physical activity (SQUASH) questionnaire was used to retrospec-

tively analyze the habitual physical activity behavior of 273 patients after primary THA.²⁶ In that study, patients were compared with an age- and sex-matched normative population. The results showed that there were no significant differences in total amount of physical activity or time spent in different categories of physical activity between the THA group and the normative group. The only difference was that patients with a THA spent significantly more minutes per day doing activities of moderate intensity.²⁶ However, that study, as well as the previously mentioned studies,²¹⁻²³ can be criticized because of their retrospective design. Consequently, our previous study was limited by a wide variation in individual follow-up time (17-78 months). Its generalizability was limited by the fact that the study was conducted in a single university center and the patient group included patients who had had a THA because of primary or secondary osteoarthritis (OA).

The aim of the current study was to determine the physical activity of patients after THA. We addressed challenges to the validity of previous studies by executing a large prospective multicenter cohort study. In this study, we assessed the habitual physical activity behavior and adherence to guidelines of health-enhancing physical activity of patients 1 year after a primary THA due to primary OA. One year postoperatively is generally accepted as the point at which patients are completely recovered from their THA surgery.²⁶ Physical activity behavior also was analyzed in different age groups. We hypothesized that amount of physical activity and adherence to guidelines decrease as people age. Finally, we assessed the value of a number of determinants in predicting amount of physical activity and adherence to guidelines.



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Method

Setting and Participants

A prospective cohort study was conducted in 3 orthopedic centers (1 university medical center and 2 regional hospitals) in the Netherlands. Based on information from the hospital records, all patients who had undergone an elective primary THA because of primary OA of the hip between February 2005 and January 2007 were consecutively included. Patients who had died at the time of follow-up, who had other lower-limb arthroplasties performed in the period of follow-up, or who had cognitive limitations were excluded. A self-report questionnaire with an explanatory letter was sent to the patients approximately 1 year postoperatively (mean=52.4 weeks, SD=3.9). Patients who did not reply within 3 weeks received a telephone call.

Subanalyses were performed for participants in 2 age groups (≤ 75 and > 75 years). These age groups were based on a classification used by Dutch government agencies.⁶ Surgeries were performed by 15 staff surgeons or under direct supervision of one of these surgeons. Patients were operated on using a posterolateral or anterolateral approach. This approach was surgeon-specific, with each surgeon consistently using the same approach for all THAs performed during the study period. Different types of implants and fixation were used. Patients were allowed full weight bearing the second day after surgery, using crutches during the first 3 postoperative months.

The study was conducted in accordance with the regulations of the medical ethics boards of the participating hospitals. Patients were informed in an accompanying explanatory letter that return of the completed questionnaire would be taken as consent to participate.

Table 1.

The Dutch Physical Activity Guideline⁸

Age Range	Light Intensity	Moderate Intensity	Vigorous Intensity
Adults (18–54 y)	2–4 METs ^a	4–6.5 METs	≥ 6.5 METs
Older adults (≥ 55 y)	2–3 METs	3–5 METs	≥ 5 METs

^a MET=metabolic equivalent.

Instruments

The questionnaire sent to the participants contained questions about demographic characteristics and the presence of additional comorbidities or complaints in the lower extremities. It also contained a physical activity questionnaire, the SQUASH.^{27,28} The SQUASH contains questions on activities at work or school, commuting activities, household activities, and leisure activities, thus measuring habitual physical activity level. It is structured to allow assessment of adherence to the international and Dutch physical activity guidelines and is used by the Dutch government to monitor the physical activity behavior of the general Dutch population.

The questionnaire asks the individual to recall his or her physical activity during an average week over previous months and consists of 3 main queries: days per week, average time per day, and intensity (effort). Using the Ainsworth Compendium of Physical Activities,²⁹ a subdivision of activities is made into 3 intensity categories—light, moderate, and vigorous—based on metabolic equivalents (METs). A *metabolic equivalent* is defined as the energy expenditure for sitting quietly. Activities with METs higher than 1 are defined as having multiples of the resting metabolic rate. Cutoff points for intensity categories are based on the Dutch physical activity guideline,⁸ which are derived from international

The Bottom Line

What do we already know about this topic?

Research on physical activity after primary total hip arthroplasty (THA) is scarce. Those studies that have been conducted provide a general impression of the level of physical activity; however, they do not provide detailed information on duration, frequency, and energy expenditure.

What new information does this study offer?

To the authors' knowledge, this is the first prospective study to conduct an in-depth analysis of physical activity behavior of patients 1 year after THA.

If you're a patient, what might these findings mean for you?

Younger patients are physically more active than older patients. Besides age, body mass index was found to be an important determinant of physical activity behavior. After hip replacement surgery, patients with a THA adhere to guidelines for health-enhancing physical activity to the same extent as the general population.

Physical Activity Behavior After Primary Total Hip Arthroplasty

Table 2.

Main Characteristics of Participants After Primary Total Hip Arthroplasty (Total Group and Different Age Groups)^a

Variable	Total Group (N=653)	Participants Aged ≤75 y (n=473)	Participants Aged >75 y (n=180)	P
Age (y), mean (SD)	70.3 (8.2)	66.5 (6.3)	80.0 (3.3)	<.01
Sex (male/female), n (%)	170 (26.0)/483 (74.0)	128 (27.1)/345 (72.9)	41 (22.8)/139 (77.2)	.33
Body mass index (kg/m ²), mean (SD)	27.0 (4.1)	27.3 (4.2)	26.1 (3.9)	<.01
Family status, n (%)				<.01
Lives alone	223 (34.2)	119 (25.1)	104 (57.8)	
Lives with partner	386 (59.1)	317 (67.0)	69 (38.3)	
Lives with partner and children	28 (4.3)	27 (5.7)	1 (0.6)	
Lives with children	7 (1.1)	5 (1.1)	2 (1.1)	
Unknown	9 (1.4)	5 (1.1)	4 (2.2)	
Educational level (highest completed), n (%)				<.01
Lower	322 (49.3)	222 (47)	100 (55.6)	
Secondary	201 (30.8)	150 (31.7)	51 (28.3)	
Higher	65 (9.9)	52 (11)	13 (7.3)	
Other	15 (2.3)	10 (2.1)	5 (2.8)	
Unknown	50 (7.7)	39 (8.2)	11 (6.1)	
Comorbidity, n (%)				.33
None	181 (27.7)	134 (28.3)	47 (26.1)	
1–2	263 (40.3)	195 (41.2)	68 (37.8)	
>2	209 (32.0)	144 (30.5)	65 (36.1)	
Complications, n (%)	47 (7.2)	29 (6.1)	18 (10)	.09
Complaints in lower extremities, n (%)	271 (41.5)	186 (39.3)	85 (47.2)	.36

^a Student *t* test was used to compare age and body mass index. Chi-square test was used to compare sex, complications, and complaints of the lower extremities. Mann-Whitney *U* test was used to compare family status, educational level, and comorbidity between participants in the 2 age groups.

physical activity guidelines.⁹ Activities with a MET value lower than 2 are not included because they are considered to contribute negligibly to the habitual activity level (Tab. 1). Participants were considered to be meeting the guidelines if they spent 30 minutes or more in moderately intense or vigorously intense physical activity at least 5 days a week, as this study was conducted before the issuing of the updated 2007 guidelines. The SQUASH has been tested for validity and reliability using an accelerometer as the criterion measure in a general adult population²⁸ and in an older adult population after primary THA.²⁷ Based on the results of these studies, the SQUASH can be considered to be sufficiently reliable and valid to measure the level of physical activity. Age,

sex, details about the operation, and postoperative complications were extracted from the patients' medical records.

Data Analysis

Statistical analyses were performed using SPSS software, version 16.* Descriptive statistics were used to describe the main characteristics of the participants. Student *t* tests were used to compare continuous variables (age and BMI) between the 2 age groups. The chi-square test was used to compare categorical variables (sex, complications, and complaints in the lower extremities), and the Mann-Whitney *U* test was used to

*SPSS Inc, 233 S Wacker Dr, Chicago, IL 60606.

compare family status, educational level, and comorbidity. Due to the skewed distribution of data with respect to the outcomes in physical activities and the activities' intensity, the Mann-Whitney *U* test was used to compare the 2 groups. To determine whether aspects of patient characteristics (age, sex, BMI, family status, education, complaints in the lower extremities, and comorbidity, included as dummy variables) and the occurrence of complications and hospital of surgery (independent variables) were predictive for the amount of physical activity (dependent variable), a linear regression analysis (backward selection) was used. Differences in meeting the guidelines between age groups were assessed by means of a Mann-

Table 3.Overview of Physical Activities of Patients After Primary Total Hip Arthroplasty (Total Group and Both Age Groups)^a

Variable	Total Group (N=653)	Participants Aged ≤75 y (n=473)	Participants Aged >75 y (n=180)	P ^b
Activities at work	99.0 (404.6)	135.1 (470.1)	4.3 (35.9)	<.01
Activities to/from work	28.3 (183.1)	34.0 (200.6)	13.5 (125.3)	.01
Household activities	756.3 (766.5)	802.6 (786.8)	634.8 (698.1)	<.01
Leisure activities	584.5 (657.8)	660.8 (710.4)	384.2 (436.0)	<.01
Sports activities	68.3 (185.0)	81.6 (207.3)	33.6 (98.8)	<.01
Bicycling	164.9 (283.7)	192.0 (303.7)	93.8 (207.4)	<.01
Walking	175.2 (241.2)	180.9 (254.9)	160.1 (200.9)	.65
Light intensity	805.1 (800.4)	874.9 (834.6)	622.1 (671.1)	<.01
Moderate intensity	333.6 (508.0)	380.0 (562.5)	211.8 (292.0)	<.01
Vigorous intensity	329.4 (458.5)	377.6 (475.8)	202.8 (382.9)	<.01
Total	1,468.1 (1,138.3)	1,632.6 (1,175.7)	1,036.8 (903.7)	<.01

^a Values are expressed as mean minutes per week (SD).^b Comparison between participants in both age groups (Mann-Whitney *U* test).

Whitney *U* test. Binary logistic regression modeling (backward selection) was used to determine whether patient characteristics, the occurrence of complications, and hospital of surgery (independent variables) were predictive in meeting the guidelines (dependent variable). The dependent variable (meeting the guidelines) was coded as 0 (not meeting the guidelines) or 1 (meeting the guidelines). Odds ratios (ORs) and 95% confidence intervals (95% CIs) are reported. A *P* value of <.05 was considered statistically significant.

Role of the Funding Source

This study was supported by a grant from University Medical Center Groningen.

Results

Of the 848 eligible participants, 653 (77%) completed the questionnaire and were included in the study. Main characteristics of participants in the total group and the 2 age groups (≤75 and >75 years) are shown in Table 2. Complications occurred in 47 participants (7.2%). There were 8 dislocations (1.2%), 3 sciatic nerve

palsies (0.5%), 3 superior gluteal nerve palsies (0.5%), 2 periprosthetic fractures (0.3%), and 2 malpositioned prostheses necessitating revision surgery (0.3%). Comparison of characteristics between groups showed more individuals living alone (*P*<.01) with a lower educational level (*P*<.01) among the older participants, and a higher BMI among the younger participants (*P*<.01) (Tab. 2).

The participants spent a mean of 1,468.1 minutes on total physical activity during the week (Tab. 3). Most of the time was spent in household activities and leisure activities. With respect to intensity of the activities, most of the time was spent in light-intensity physical activities.

Subanalyses for participants in the 2 age groups showed that those aged >75 years had a lower total amount of physical activity (*P*<.01) than those aged ≤75 years. They spent less time in activities at work (*P*<.01), activities to and from work (*P*=.01), household activities (*P*<.01), leisure activities (*P*<.01), and bicycling (*P*<.01). Fur-

thermore, they spent less time in light-intensity (*P*<.01), moderate-intensity (*P*<.01), and vigorous-intensity physical activities (*P*<.01) (Tab. 3).

The results from the linear regression model showed that age at the time of the operation (*b*=−52.95, 95% CI=−62.95 to −42.96, *P*<.01) and BMI (*b*=−31.16, 95% CI=−51.02 to −11.31, *P*<.01) significantly predicted patients' level of physical activity, with younger participants and those with a lower BMI showing higher activity levels. The *R*² value for this model was 0.15, which implies that 15% of the total variance could be explained.

Participants adhered to the recommendations of health-enhancing physical activity in 67.0% of cases. This percentage was 72.0% for participants aged ≤75 years and 53.9% for those aged >75 years.

Binary logistic regression analysis showed that younger participants (OR=0.95, 95% CI=0.93 to 0.97, *P*<.01), male participants (OR=0.95, 95% CI=0.93 to 0.97, *P*<.01),

and those without complaints in the lower extremities (complaints coded as 1 [yes] or 0 [no]) (OR=0.58, 95% CI=0.41 to 0.81, $P=.01$) met the guidelines more often. The validity of the model is reflected in the Hosmer-Lemeshow goodness-of-fit statistic ($\chi^2=8.631$, $P=.37$), which tests the hypothesis that the observed data are significantly different from the predicted values provided by the model. A nonsignificant value for this test indicates that the model predicts real-world data fairly well.³⁰ The Nagelkerke R^2 value for the model was 0.095, which implies that 9.5% of the variance could be explained. The model could classify 68.6% of the patients correctly.

Discussion

Despite the beneficial effects of physical activity on general health and musculoskeletal fitness, and the recognition of its potential role as a negative determinant of prosthetic wear, little is known about the habitual physical activity behavior of patients after primary THA. To our knowledge, this is the first prospective multicenter study to conduct an in-depth analysis of habitual physical activity behavior, giving a first impression of the habitual physical activity behavior of patients 1 year after primary THA. From the results, it can be concluded that the participants were physically active a mean of 1,468 minutes per week. The most time was spent in household and leisure activities. Younger participants were more physically active than older participants. A lower BMI value was predictive of a higher level of physical activity. The participants adhered to the guidelines of health-enhancing physical activity in 67% of cases. The guidelines were met more often by younger participants, male participants, and those not reporting problems in the lower extremities.

Comparison of the results of our study with those of previous studies

is hampered by the fact that, so far, level of physical activity has been determined predominantly by means of categorical scoring tools such as the UCLA Activity Score²⁴ and the Grimby scale.²⁵ These scoring tools categorize activity level of patients, but fail to provide detailed information on duration, frequency, and energy expenditure of activities performed by patients. Furthermore, these scoring tools have not been validated. Results of studies that used the UCLA Activity Score indicate a moderate activity level in patients at least 3 years after THA.^{21,22,31} Using the Grimby scale, a light- to moderate-intensity activity level was found in patients 1 to 2 years after THA.²³ In interpreting these results, it should be noted that these studies differ from our study not only with respect to the scoring tool used but also with respect to the populations in which physical activity was measured, as well as point of follow-up.

We are only able to compare the volume of physical activity found in this prospective study with the results of an earlier retrospective study at our department.²⁶ This earlier cross-sectional study addressed habitual physical activity in a cohort of patients who had a primary THA because of primary or secondary OA of the hip. After a mean follow-up of 39 months (SD=14.1), we found a mean of 1,601.0 minutes per week of physical activity in a group of 273 patients (mean age=62.7 years, SD=13.7). This total amount of physical activity is slightly higher than in the current prospective multicenter study of 653 patients, perhaps because the mean age of the patients was lower than in the current study. It also might reflect a slight further increase of physical activity in the years after the surgery. As in the current study, most of the time was spent in household activities (mean=642.6 min/wk) and leisure activities (mean=550.8 min/wk),

and mostly light-intensity activities were performed (mean=1,003 min/wk).

When comparing the physical activity of patients in the 2 age groups, total amount of physical activity as well as levels in subcategories of physical activity appeared to be higher in younger patients. This finding supports the presumption of higher activity levels in younger patients as a possible explanation for their observed lower prosthetic survival rates.^{32,33}

Assessment of the determinants of physical activity also showed the influence of age and BMI. Presence of comorbidity or occurrence of complications after the operation was not predictive of physical activity level. As numbers of complications were low, these data should be interpreted with caution.

Among the general Dutch population, 60.9% of those younger than 75 years and 50.7% of those older than 75 years adhered to the guidelines of health-enhancing physical activity in 2008.⁶ These percentages appear to be lower than our results, which showed adherence percentages of 72% in patients aged ≤ 75 years and 53.9% in patients aged >75 years. The results of the binary logistic regression analysis showed that younger patients, male patients, and patients without problems in the lower extremities adhered to the guidelines more often. However, only 9.5% of the variance could be explained, which can be considered relatively low, and only 68.6% of patients could be classified correctly, which is only slightly more than would be expected based on random classification.

Our study may have some limitations. The first potential limitation is related to the fact that we did not perform a nonresponse analysis;

thus, there might have been a selection bias. However, our study was characterized by a high response rate (77%) and a large sample size (N=653). Second, we used a self-administered recall questionnaire to assess level of physical activity. Although self-report instruments continue to be the most widely used type of physical activity measure, allowing collection of data from a large number of people at low costs, there are limitations to their use. Recalling physical activity is a highly complex cognitive task, and instruments can vary in their cognitive demands. Older adults, in particular, may have memory and recall skill limitations.³⁴ However, the SQUASH has been validated in a population of adults,²⁸ as well in a population of older adults after primary THA,²⁷ showing identical measurement properties. These measurement properties of the SQUASH also are comparable to those of other physical activity questionnaires.^{34,35} Additionally, a limitation of self-report questionnaires is that people tend to overestimate their physical activity level.³⁴ Finally, it can be argued that the absence of preoperative data on physical activity can be considered as a limitation, as well as the fact that we did not take other factors into account such as patients' mental health status (eg, depression) or frailty.

Conclusion

This study has given a first impression of the physical activity of patients 1 year after primary THA surgery. It showed that younger patients are physically more active than older patients. Besides age, BMI was found to be an important determinant of physical activity behavior. Furthermore, the study showed that the extent to which patients adhere to guidelines of health-enhancing physical activity varies with age and sex, although the percentages found appear to be in line with those of the general population. Although this

finding can be considered a successful outcome after THA, it also means that large proportions of patients 1 year after primary THA are insufficiently physically active. Given the beneficial effects of regular physical activity, these patients should be stimulated to become physically more active.

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